TOOTH WEAR AS OBSERVED IN ANCIENT EGYPTIAN SKULLS

PUECH P.-F., prefatory comments and attached study concerning the Guimet mummy at Lyon.

LEEK Frank F. (1903-1985), is one of the great names in Egyptology. Trained as dentist at King's College Hospital Dental School, 1926-30, he spent his life interested in human mummies and worked with the team that examined the mummy of Tutankhamun in 1968 (see *Who Was Who in Egyptology,* 3rd ed. 1995, p. 242). Apart from this famous feat, he was an outstanding scientist and published many researches in the Journal of Egyptian Archaeology. and I enjoyed to carry on researches with him through the Marro collection, Department of Anthropology, University of Turin (Italy).

It has been known for long time that Egyptian mummies and skeletons are an invaluable scientific material, the importance of which grows steadily, showing new possibilities of using it. Since I had in common with Franz Filce Leek a particular interest for research on dental disease, the ancient Egyptians provided a field for investigations.

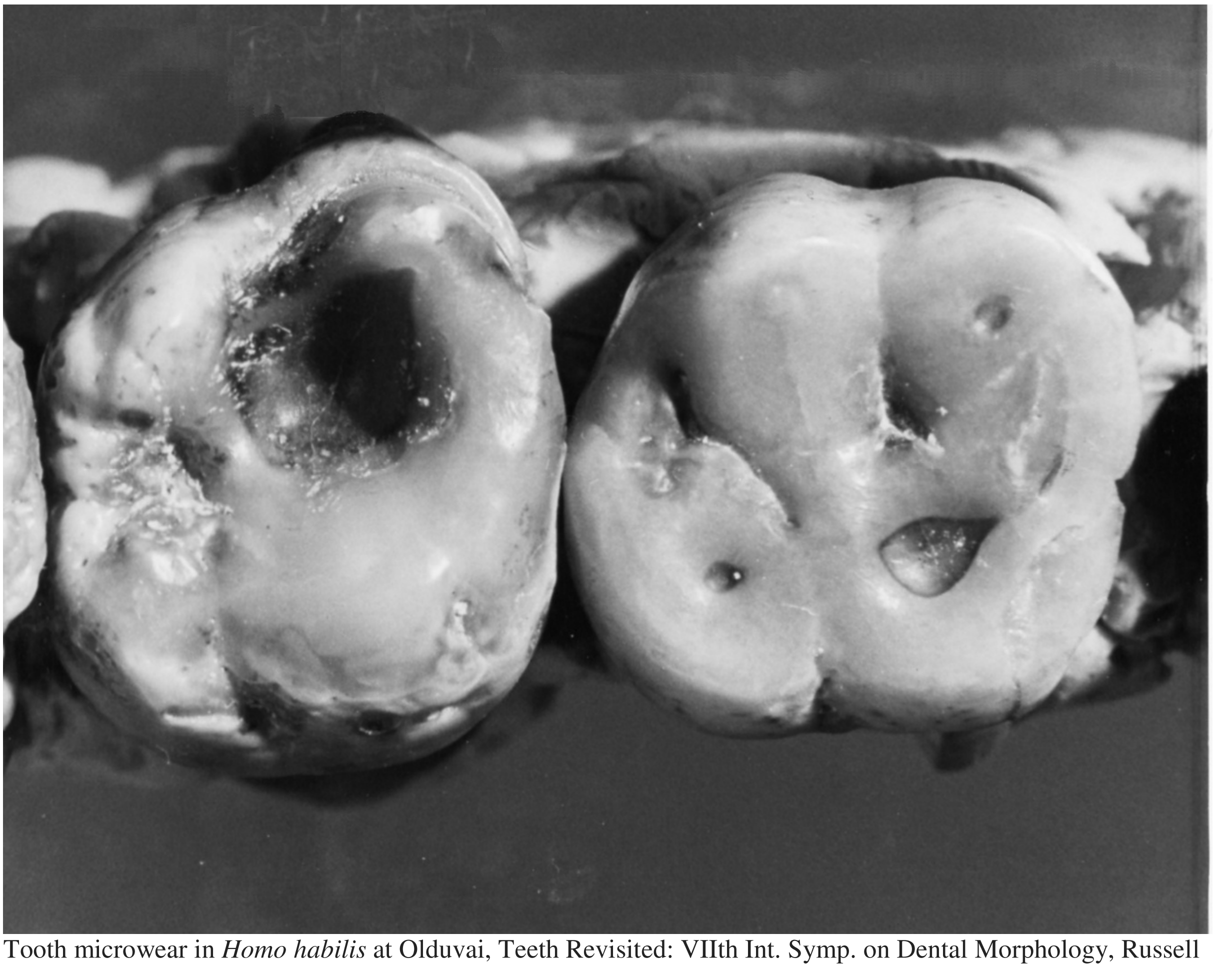
In order to study the variability of the dental micro wear pattern of a human population and the possible correlation with diet, dentitions were examined to demonstrate the effects of all possible events that occur during mastication - figure n°1: Marro collection n°67-20

In fact, tooth micro wear shows a high degree of similarity in the selected dentitions for presenting no osseous pathology. Compared to a study of tooth wear in animals and humans of known diet, the character of wear of the pre-dynastic and dynastic Egyptians was attributed to the vegetables used both in the diet and as masticators.

Diet of the common Egyptian was rich in vegetables, fruit, fish and a limited amount of meat. Bread and beer were the dietary staples of this period of ancient Egypt. Moreover, foods were preserved in salt, perhaps posing additional dental wear risks.

Specific features and especially hollows forming cups in dentin are described for possible comparative studies on diet in paleoanthropology. These characteristic features having been attributed to a combination of abrasion and erosion, provide na new source of information in the study of "Paleo-diet". Prehistoric man, being a hunter gatherer, certainly used what was on hand that varied quite a bit from one place to another.

References are to be based on populations that sustained a diet sufficiently known to give confiding evidence. We are aware that, for instance, if traditional Inuit diets are in some places still remarkably carnivorous, they find ways to make the most of their limited options. Tooth wear as observed in ancient Egyptian skulls gives us, after the research presented in the following pages, one possible clue to the cause of the burnished appearance of some hominid teeth as it is presented in figure n°2.



Tooth microwear in *Homo habilis* at Olduvai, Teeth Revisited: VIIth Int. Symp. on Dental Morphology, Russell D.E., Santoro J.-P. and Sigogneau-Russell D. eds., 1986 Mem. Mus. natn. Hist. nat., Paris, serieC, 53:399-414

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Tooth Wear as Observed in Ancient Egyptian Skulls

Recent investigations have shown the possibility of using the microwear of teeth to provide information about the diets of ancient man. This study presents the results of a macro- and microscopic survey of dental wear patterns related to food habits in ancient Egypt. The study is based on the Marro collection (Institute of Anthropology, Turin, Italy). Due to the sample size of the collection this examination shows a high degree of regularity in the microwear patterns along this population.

1. Introduction

The exceptionally dry climate and the burial customs of the ancient Egyptians have combined to give more information of the history and daily lives of these people, than has been gained about any other civilization of comparable date. The most remarkable dental characteristic of the ancient Egyptians is the magnitude of the abrasion on the cusps of the teeth, the predisposing cause of considerable dental disease and sepsis. Frequently the enamel and dentine were worn away until the pulp chamber became exposed and its necrosis allowed the passage of bacteria through the apex, to be followed by abscess formation and cysts (Ruffer, 1920). As recent research with the aid of a microscope has shown the connection between the type of wear and food (Puech, 1976; Rensberger, 1978; Walker, 1979) the purpose of the present work is: (I) to scale the degree of wear; and (2) to describe the microscopic appearance of the occlusal surface of the teeth of ancient Egyptians.

2. Material and method

This study is based on the Giovanni Marro collection which is held in the Institute of Anthropology, Turin, Italy. It consists of archeological recoveries from investigations carried out between 1903 and 1935 at Gebelen and Assiut in Upper Egypt and at Assuan on the Egypt–Nubian border. The collection consists of 791 predynastic and dynastic skeletons covering a period of 2500 years, and comprises examples of negroid-featured Nubians and of Egyptians (Davide, 1972).

The dynastic period extended for some 3000 years, and consequently many human remains were recovered from tombs and cemeteries. Although the practice of mummification is thought to have started during the third Dynasty, the human remains from that period and indeed from all periods are mostly in the form of skeletal material.

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It was found possible to divide the material into the following age groups:

0–19	20–29	30–49	50+
83	285	168	67

This table reveals that out of a total of 603 specimens, 368 died under the age of 30 years, so that out of the total number, 39·4% survived for a longer period. It is apparent that the degree of abrasion on the cusps of the teeth is related with age of some subjects.

The scale proposed by Scott (1979) was used to evaluate the degree of wear. The occlusal surface was divided into four quadrants and each was graded 1–10 according to its morphological aspect. The addition of the four numbers was used as the determining factor.

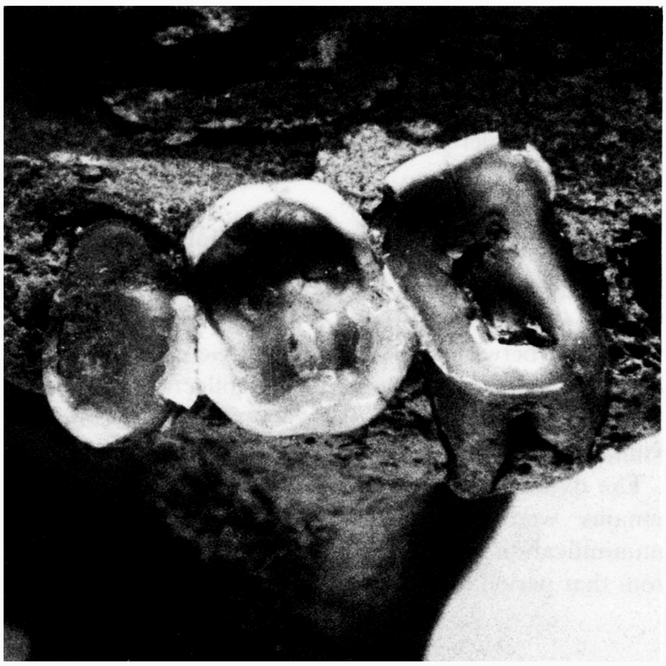
To examine individual teeth in a dentition and to facilitate examination under the light microscrope, a nitrocellular impression was made. When dry it is easily peeled off and reproduces a precise surface relief. The use of a nitrocellular varnish gives the possibility to examine portions of curved surfaces, which are almost planar, with a standardized orientation. The transmitted light through the replica material gives images of horizontal surfaces with good contrast and detail.

The wear traces are viewed under the microscope (×100). Tests have shown that great magnification results in a breakdown of precision. We have used homologous wear facets to sample microwear patterns; the selection was done to show the effects of all types of occlusal events during mastication.

3. Results

The wear on the occlusal surfaces of teeth increases with age but wear differences between teeth in the same quadrant are found to be less marked as age increases (Figure 1).

Figure 1.



The wear difference between the 1st and 2nd molars varied between 2–15 whilst the difference between the 2nd and 3rd molars was 0–10. This result underlines the wide diversity of wear.

The average wear difference between the 1st and 2nd premolar was three, which conforms to the eruption sequence. On average, the wear on the the 1st molar was only 1·5 times higher than that of the 1st premolar wear. This would indicate that the type of food required the same amount of mastication from all the teeth in the buccal segment.

The use of Scott's quotient of the five teeth in the buccal segment enables a comparison to be made between different dentitions (Table 1). It must be emphasized that as the dental wear increases with age, for comparative purposes, the two factors must be assessed together.

Table 1 **Occlusal face teeth in ancient Egyptians according to Scott's (1979) wear scale**

Subject	Side	Maxillar teeth					Mandibular teeth				
		P1	P2	M1	M2	M3	p1	p2	m1	m2	m3
1	r	40	40	38	32				33	25	24
	l	40	39	38	30	26		25	33	25	25
2	r	40	38	38							
	l		40				37	32	36		32
3	r		36	35				40			32
	l	38	36								
4	r					5	14	8	8	6	
	l							8	5		
5	r	20	18	30		16	14	18	27		16
	l			35	22	16	24	20	27		18
7	r	40	40			4			20	34	30
	l	40	40		34			28	24	40	38
14 (24)	r	22	26	27							
	l	18	20		22						
22	r			37	22	12					
	l			30	20						12
29	r				22	24	22	24		30	
	l		40								21
34	r					30	34	36			38
	l			38	32	32				38	
36	r	40				20			34	34	24
	l	37							38	32	26
667	r	24	30				20		20	15	9
	l		22	29				19	27	13	8
688	r	19	15	21	10	8			18	14	6
	l			22	12				18	13	6
EPG 50520	r		16	20	17						
EPG 66532	l	21		21		9					

The wear on the majority of the molar cusps in this collection take the shape of an inverted cupola. In order to find if this wear was due to the abrasive elements in the food or to strong occlusal pressures, it was necessary to examine the proximal wear. Such wear was seen in certain primates eating a resistent diet and was due to the powerful occlusal forces. Measurements were made with a vernier micrometer (Puech, 1982) and the results are shown in Table 2. Wear distribution according to Scott's scale is shown in Figure 2.

Table 2 **Proximal wear of cheek mandibular teeth of ancient Egyptians; measure (in mm) of contact between 2nd premolar and 1st molar and between 1st and 2nd molar**

Subject		Teeth (sup.)		Teeth (inf.)	
	Side	P2–MI	MI–M2	p2–m1	m1–m2
1	r	0	2·5	3·6	3·5
	l	0	2·2	3·4	4·2
3	r	3·9			
	r				
4	r			1·8	
	l			3·1	
5	r		0	0	
	l			4·7	3·3
7	r			0	3·9
	l			0	3·2
22	r		3·5		
34	r			3·9	4·1
	l			3·5	4·6
36	r				4·1
	l				0
667	r				2·6
	l			3·9	3·5
668	r	4·15			4·5
	l				3·7
EPG 50	r	4·7	5·2		
EPG 66	l		4·9		

Subjects EPG 50; EPG 66; 7: 667: 668 have an occlusal facet wear of 1st molar near to a score of 20 of Scott's scale.

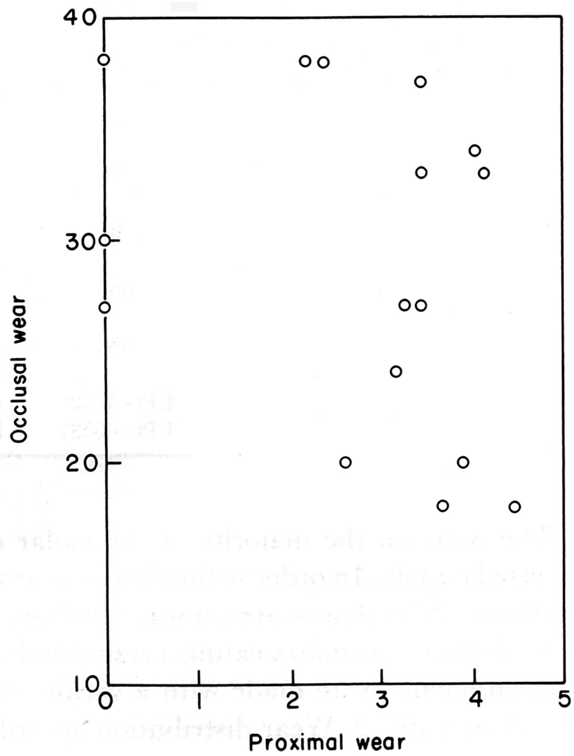


Figure 2. G. Marrow collection: dynastic and predynastic Egyptians: distal facet wear distribution related to occlusal attrition (Scott, 1979 scale).

Usually the proximal wear was in direct proportion to the occlusal wear, but major discrepancies can arise when a tooth or teeth are missing from a quadrant or when they are in malocclusion. However, in subjects with but little wear (1st molar about 20 in Scott's table), proximal wear approximates to that of European *Homo erectus* and the *Meganthropus* wear (Table 3). For this reason it was thought that the inverted cupola-shaped wear on these ancient Egyptian teeth, was due to strong occlusal pressures and to the mastication of resistent elements.

Table 3 **Proximal wear of cheek teeth in mandibles of *Meganthropus* and *Homo erectus*. Measure of contact between 2nd premolar and 1st molar and between 1st and 2nd molar**

Specimen	Side	p2–mI	ml–m2
Meganthropus	r	2·3	3·0
Mauer	r	4·1	4·2
	l	4·6	4·2
Arago XIII	r	4·6	4·5
Montmaurin	r	4·5	5·2
	l	4·5	4·6

Specimens have an occlusal facet wear of 1st molar near to a score of 20 of Scott's scale.

Action of Mastication

Of the four cusps of an upper molar tooth, the mesio-lingual was the largest and the one most quickly worn during the two phases of trituration. The occlusal cusps guide the occlusion and clenching of the opposite arcades.

Phase 1 of chewing begins with the association of tooth–food–tooth of the lower molars moving sideways (buccal cusps of the lower molars facing the buccal cusps of the upper molars) and the upward movement proceeds to end in a centered occlusion, in which the intercuspidation is at its maximum. This phase produces a series of wear facets covered with striations on the lingual slopes of the cusps of the upper molars (Figure 3) and on the buccal slopes of the cusps of the lower molars.

Phase 2 follows this movement from the centered clenching position and its end brings the teeth on the active side into disocclusion and the teeth on the opposite side into near contact. This phase engages the buccal slopes of the upper molars, and the lingual slopes of the buccal cusps of the lower molars, which are covered with fine flakes (Figure 4). Consequently this movement of food which is guided by the curved surfaces, exerts a wear concentration caused by the abrasive particles.

To demonstrate this microscopic appearance, three examples are illustrated.

(1) Young predynastic female with negroid features: EPG 50520, from Gebelen. The three remaining teeth in this dentition exhibit a reduction in the height of each cusp, and in the area of the erstwhile mesio-lingual cusp, an inverted cupola exists in the dentine, and is bordered by an area of rounded and eroded enamel. The striations are blunt (Figures 3 and 4) and less numerous than in prehistoric man (Puech, 1982) therefore they seem not to have been produced by a large number of abrasive particles.

(2) Predynastic adult male: EPG 66532, from Gebelen. This specimen also has three retained teeth. These reveal more wear than did the previous example, and there is a

Figure 3.

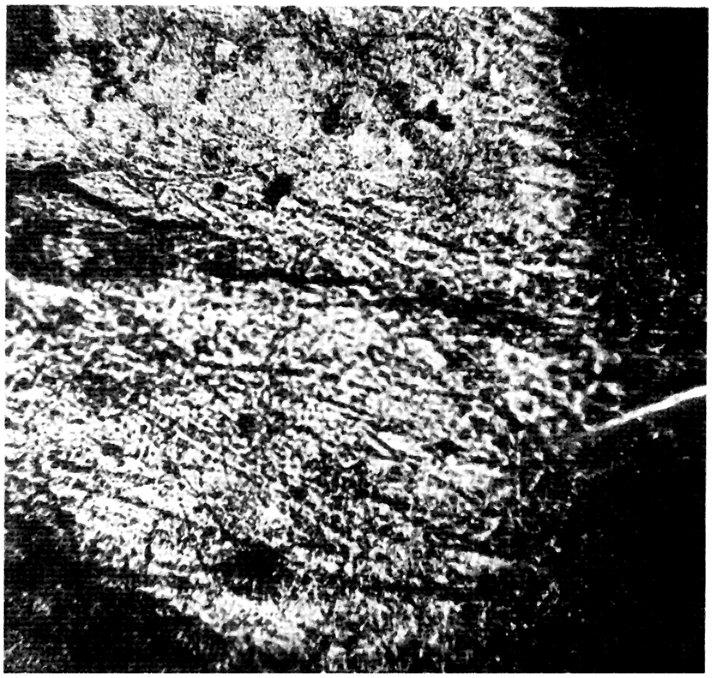
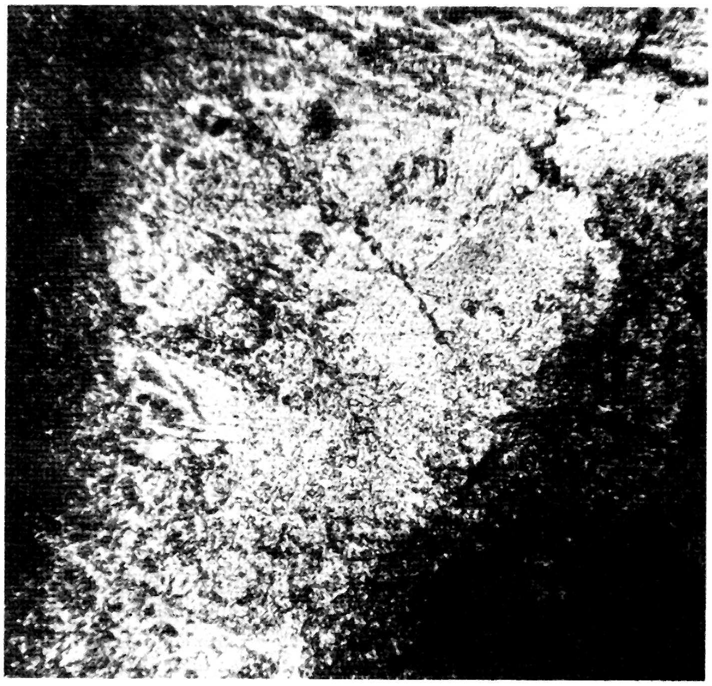


Figure 4.



coalescence of three areas of dentine on the 2nd upper left molar. The enamel overhangs the dentine with convex surfaces. The curved aspect of the occlusal enamel and the prevalent blunt line demonstrates the abrasive effects of the food. There are few striations and these are polished which suggests that although there was considerable mastication of food, no large abrasive particles of external origin were within it. The food however contained internal abrasive particles too small to produce striations but with a high polishing power (Figure 5 and 6).

(3) A slim adult, *ca.* 25 years: 600, from Assuit, Dynastic 2400–2000 B.C. Most of the teeth are present in both dentitions and show a more advanced degree of wear than did the previous examples. All the incisor teeth as well as the molar teeth are affected. This may point to a non-specialization of the choice of food, and to a slow but prolonged mastication as well to an edge to edge articulation.

Microscopic examination reveals the same characteristics of the enamel and dentine as the two previous examples. Rounded surfaces dominate as seen on the occlusal surface of the upper left second molar. Figure 7 shows the lingual edge of the mesio-lingual cusp whilst Figure 8 illustrates the disto-lingual one.

Microscopy of Tooth Wear

It has been shown that desert Bedouins consuming the same diet as those in Arabic villages, sustain twice the amount of tooth wear (Smith, 1972). One possible clue to the cause of tooth wear could therefore be gained from a study of the geology of the habitation areas. In ancient as well as in present times, fertile soil on the banks of the Nile was so precious for cultivation, that all the villages were built on the very desert itself. Consequently contamination of foods by wind-blown sand could not be avoided. It is to be expected that many striations on the dental cusps would be seen under the microscope.

Figure 5.

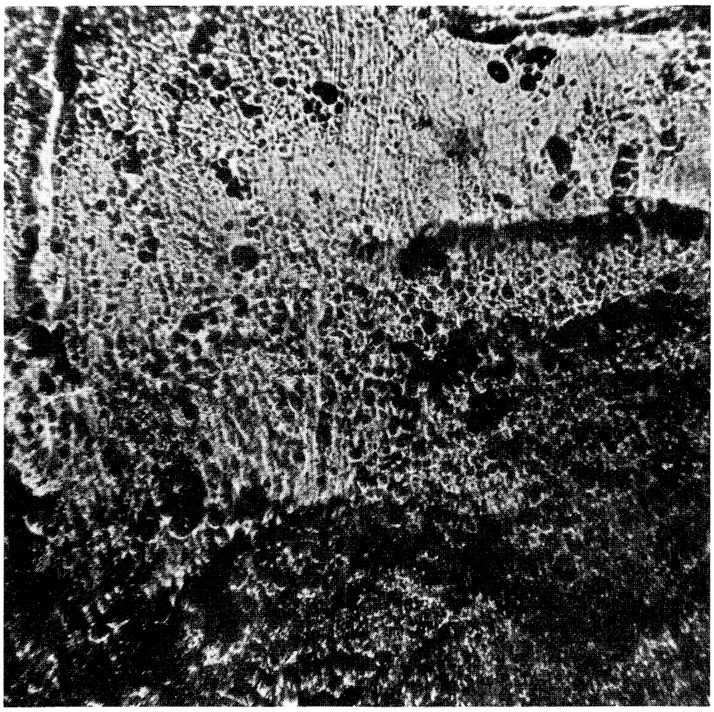


Figure 6.

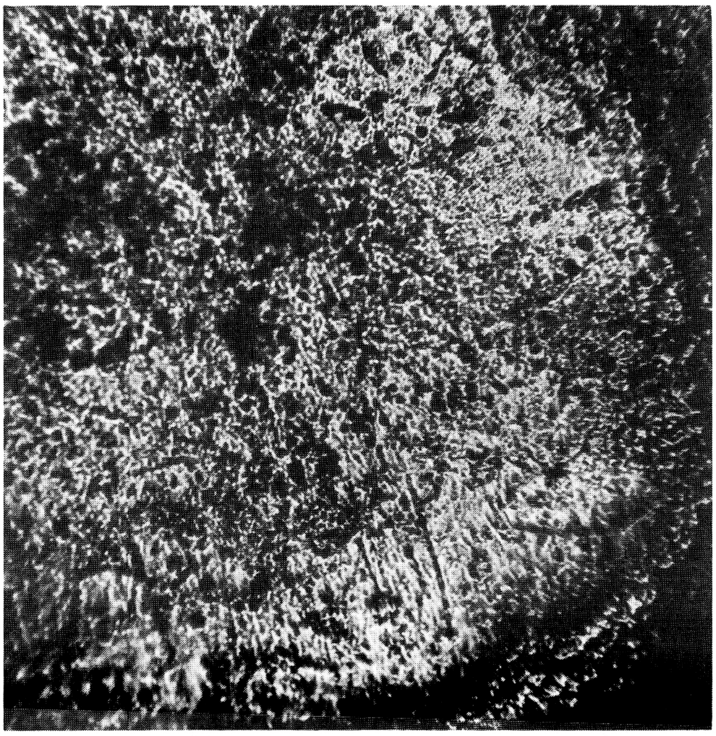


Figure 7.

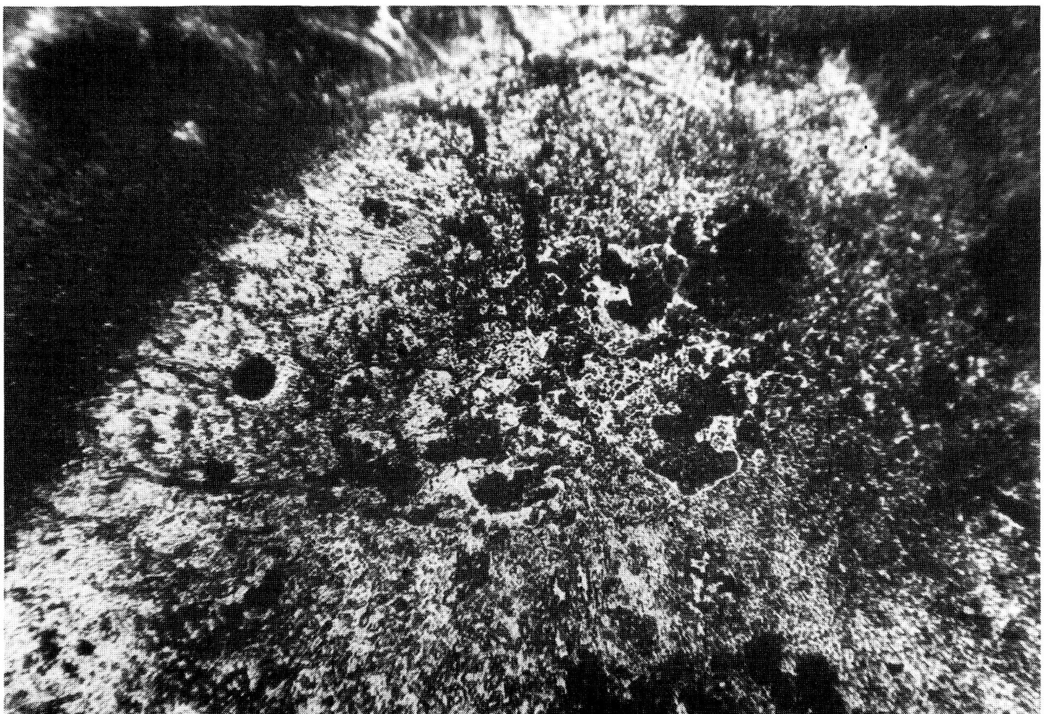
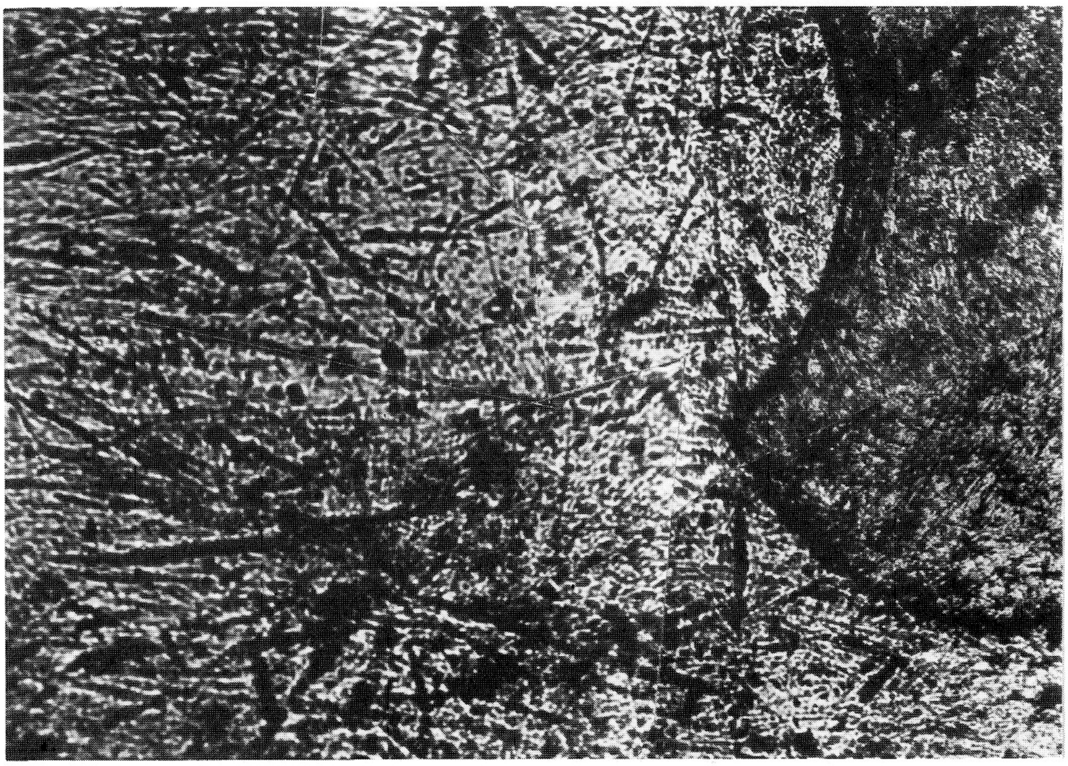


Figure 8.

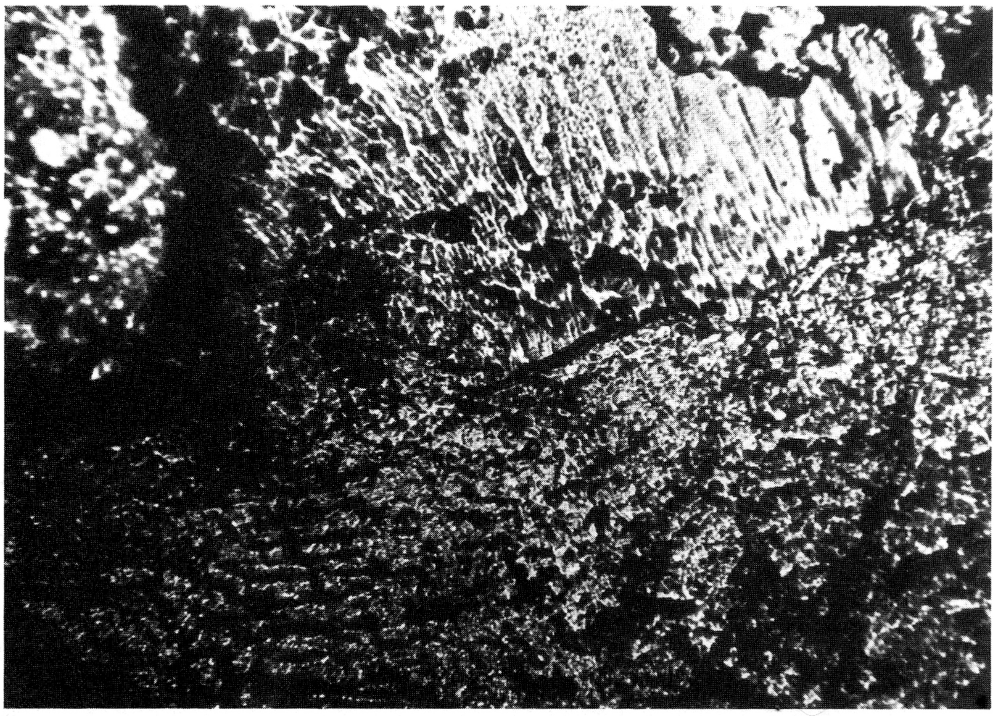
Figure 9.



Contrary to expectation however, ancient Egyptian teeth reveal a paucity of such lines.

At about 100× striations vary greatly in width, from 40 μm to less than 1 μm. Figure 9 shows the lingual side of the occlusal surface of an upper canine (subject 14). The dentine is to the right and it shows multidirectional striations, the enamel edge surrounding the dentine is covered with many flakes and the striations are oriented towards the dentine deflection. A little more to the rear and left, the striations are short and multidirectional. This area was used for food clamping and crushing. The rays in the third part to the left, are lined approximately parallel with the main axis of the tooth. If the striations are not strictly parallel, it is because there has been a superimposition of different actions. The enamel edge (Figure 10, top third) around the inverted cupola on the 1st upper molar exhibits no striations as on the previous example, but a blunt surface punctuated by wells which become furrows oriented in the direction of movement. The furrows at the bottom and edge of the area are blunt. On the dentine (Figure 10, two-thirds from the bottom)

Figure 10.



numerous waves can be seen regularly spaced and perpendicular to the enamel furrows and therefore in line with the movement. With few exceptions these descriptions characterize all the teeth in the Marro collection.

The friction between food and teeth, because of the laws of plasticity, produce extremely high pressures, and is reflected in the blunt aspects previously described. These are due to the friction engendered between the food and the teeth. Figure 11 shows the enamel edge (at the top) with wells and an erosion aspect, marked by a selective tearing out which discloses a net-like pattern. This pattern explains the blunt aspects as seen in Figure 12, which with further usage may well be transformed into rough surfaces due to the action of friction.

Figure 11.

Figure 12.

4. Discussion and Conclusions

The study of various populations of Australian Aborigines has shown that the speed of dental wear can be the same in groups consuming quite different diets (Richard & Brown, 1981). The reason could be that the different foods have the same abrasive content, or a common physical quality of hardness or even, that the Aborigines have a universal habit of chewing masticatories.

Yarnell (1977) has shown that primitive people have no sophisticated techniques for tenderizing meats and plain cooking is the only type of preparation. This is supported by his examination of human faeces from the archaic period in Kentucky (U.S.A.) in which he found many bone splinters, pieces of bark and even a small mammal with its fur.

With a sedentary population, bread and puddings make up the major part of a menu, completed with uncooked fruits. Under these circumstances there is little tooth wear.

The teeth of the predynastic subjects show a greater degree of wear than those of the dynastic people (Grilletto, 1977). The differing rates of tooth wear during successive periods of Egyptian history, clearly reflect a more and more elaborate food preparation since the wear decreased with civilization and with social level.

Striations on the occlusal surfaces can always be explained by the abrasive content, so often mentioned in reference to Egyptian food (Ruffer, 1920; Leek, 1972).

The nature of digested abrasives substances can be seen from the examination of animal faeces. Small stones, quartz granules (hardness 7 Mohs) and amorphous silica (hardness 5·5 Mohs) have been recorded (Barker *et al.*, 1959; Puech *et al.*, 1980).

Vegetable matter absorbs silica from the soil and stores it as amorphous silica, and microscopic examination of plant tissue shows numerous hard particles encrusted either in the membrane or within the cells, mainly however on the external sides (Parry, 1957; Sangster, 1968). These isolated concretions (opal phytolithes) are of various natures, shapes and dimensions.

Our experimental study of dental wear showed that a pressure of 10 kg, resulted in a striation of one-twentieth particle size. It has also shown that at low magnification amorphous silica within vegetable matter polishes enamel but scratches dentine, at the same time it accentuates the structural relief according to its relative hardness.

Dust and sand particles are larger than silica concretions and range in size from 50–200 μm, and therefore cut more deeply into the superficial tooth structures. Dust consists mainly of quartz granules, it is the common detritic material. When spread by wind and storm it covers everything; consequently all foods are at risk.

Dixon (1972) thinks that the wear on teeth is due to the habit of chewing vegetable masticatories, a custom mentioned in the section on tooth therapy in the Papyrus Ebers. Dixon also quotes Theophratus: "All natives in Egypt chew papyrus uncooked, boiled or roasted. They extract the juice and spit out the quid."

Cyperus papyrus is a perennial plant which grows in a marshy habitat. It belong to the Cyperean family, as *Cyperus esculentus* whose small tubercles are also eaten, rich in particular compact phytolithes. Phytolithes appear as silica at the bottom of a cell, the apex pointing towards the exterior walls. The cone, some 8 μm thick, is rarely solitary, usually grouped in a cluster containing a variable number. This variation is due to climatic conditions and soil.

A pressure of 10 kg produces a striation about one twentieth of the width of the abrasive particles; as 10 kg, is about twice the amount of pressure needed for the structural failure of

the stem, base and bulbs of *cyperus* sp. the striations produced by the chewing of a masticatory should be 0·4 μm. Since the cones are embedded in the cell structure, they probably will not exceed 0·2 μm in width. The blunt character of wear as seen through the microscope, confirms Dixon's opinion concerning the use of masticatories. In this connection, it should be noted, that the granulometric distribution of dentrifice particles is between 5–50 μm, and that their polishing power is considered satisfactory.

Cyperus papyrus has a high percentage of fibers charged with phytolithes and its mastication required the strong pressures already mentioned, and its polishing properties will produce the characteristic blunt appearance of wear seen under the microscope. The use of such masticatories develop the flow of saliva, which increases the deposit of calculus, but reduces the number of carious cavities. Both of these two latter conditions are so characteristic of ancient Egyptian dentitions.

Most of the vegetables used in the diet of ancient Egyptians had been growing in Egypt for thousands of years. *Cyperus papyrus* grew each year in the marshes. The lower part was eaten uncooked or baked in a pan, papyrus stems were also crushed for flour. In the earlier periods in Egypt other foods were very fibrous. For example fresh dates were an important food and it is likely that the inherent particulate physical structure of this fruit contributed to give to the dental crown the blunt aspect observed.

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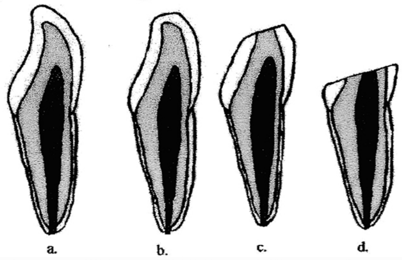
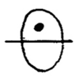
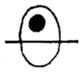
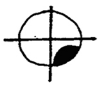
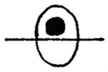
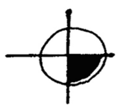
Attrition Stages



(a) 0- no attrition, (b) 1- attrition of enamel,
(c) 2- dentine visible (d) 3- exposure of secondary dentine.

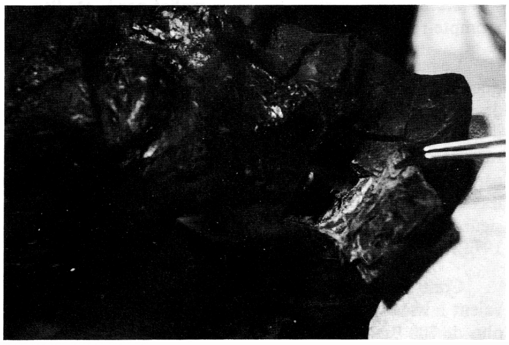
Comparative Standards for the recording of dental attrition based on Scott (1979).

	Molars	**Premolars**	**Canine/Incisor**
0	No Data	No Data	No Data.
1	Unworn: wear facets minimal	Unworn: wear facets minimal.	Unworn: wear facets minimal.
2	Wear facets large but cusps still present, pin-prick dentine exposed.	Wear facets large but cusps still present.	Wear facets large but incisal edge still clear.
3	Cusps becoming obliterated rather than clearly defined.	Cusps rounded rather than clearly defined.	Incisal edge rounded rather than clearly defined.
4	Quadrant area flat - no dentine exposure other than pinpricks.	Cusp pattern flat-pinprick dentine exposures.	Incisal edge flat-pinprick dentine exposures.
5	Quadrant flat with dentine exposure on 1/4 of quad. 	Cusp pattern flat, dentine exposed on c1/4 of cusp. 	Edge flat, small dentine exposure. 
6	Dentine exposure more than 1/4 of quadrant. 	2+ dentine exposures, clearly separated. 	Dentine exposure on 1/4+ of incisal surface. 
7	Enamel on only 2 sides of quadrant. 	2+ dentine exposures. 	Dentine patch extensive. 
8	Enamel on only one side of quadrant, but thick. 	Enamel still around edge of tooth, thick. 	Enamel around edge of tooth, thick. 
9	Enamel very thin. 	Enamel very thin. 	Enamel very thin. 
10	No enamel on quadrant.	No enamel on cusp.	No enamel on surface.

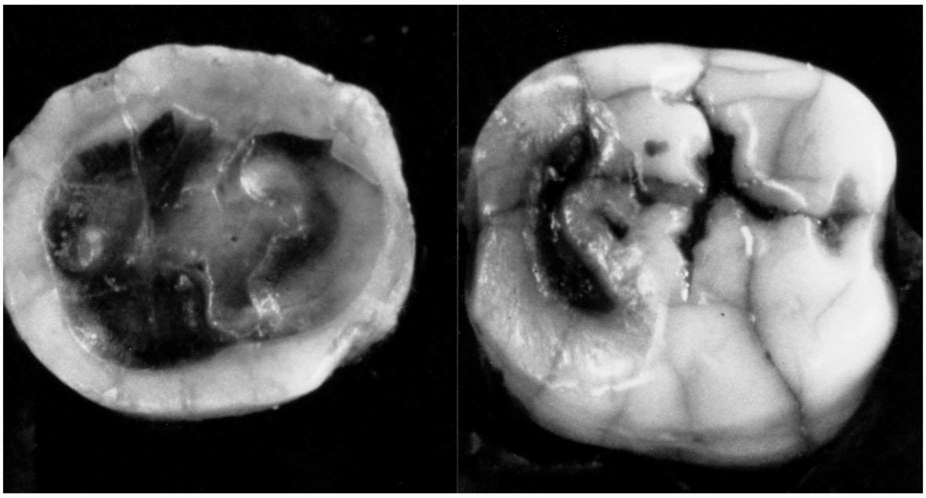
MUSÉE GUIMET

D'HISTOIRE NATURELLE DE LYON

Autopsie de la momie



ÉTUDES DENTAIRES



2.2. Examen microscopique réalisé par le Dr PUECH

L'étude microscopique de l'abrasion et de l'attrition sur la surface des dents a été préconisée, dès 1962, par DAHLBERG et KINZEY. Des expérimentations réalisées *in vitro* (RYAN 1978 ; PUECH & PRONE 1979) ont permis d'observer les interactions entre des abrasifs de géométrie et de granulométrie connues : grains de quartz détritique par exemple, avec la surface dentaire. Ces grains travaillent par coupe ou par gougeage, la distinction entre ces deux modes d'action est visible par l'examen des sillons produits. On étudie (RYAN 1979, FINE & CRAIG 1981) :

— le nombre et la direction des stries,
— leur disposition : au hasard, regroupées...,
— la façon dont débute et se termine la strie,
— leur profondeur.

De nombreuses études cinétiques ont été réalisées : *in vitro* à l'aide de simulations réalisées sur ordinateur (RENSBERGER 1973, 1978) et *in vivo* grâce à la cinéfluorographie.

Toutes ces études ont permis de mieux connaître les mouvements masticatoires.

Enfin, des corrélations entre le type d'usure des surfaces dentaires et l'alimentation ont pu être établies grâce à l'étude d'espèces animales à diète connue (KAY et HIIEMAE 1974, WALKER & alii 1978, KAY 1981). Des groupes humains dont le régime alimentaire strict était lui aussi connu ont également été étudiés (MOLNAR 1970, BONIN 1972, MOLNAR & WARD 1977, RYAN 1979).

L'observation microscopique de répliques reproduisant fidèlement les surfaces dentaires ont ainsi permis de mieux connaître les régimes alimentaires des hommes fossiles (PUECH & *alii* 1980 : PUECH 1981 ; PUECH & *alii* 1983).

Cette technique a été utilisée pour l'étude de l'usure dentaire de 603 squelettes d'Egyptiens appartenant à l'Institut d'Anthropologie de Turin (Italie) (PUECH & *alii* 1983).

Nouv. Arch. Mus. Hist. nat. Lyon, fasc. 25 p. 57-64, Lyon, 1987

Le pain et la bière forment la base alimentaire de l'antique Egypte. Le pain est alors le plus souvent cuit sous forme de galettes très résistantes dans lesquelles on trouve, parmi d'autres impuretés, des morceaux de pierre à moudre. Ces raisons ont été invoquées pour expliquer l'extraordinaire usure des dents des Egyptiens. En effet, dès le plus jeune âge, les dents sont usées à plat et l'adulte possède très souvent plusieurs dents complètement abrasées (RUFFER 1920, LEEK 1972).

Contrairement à ce que l'histoire et l'archéologie pouvaient laisser supposer, l'examen des surfaces dentaires de plus de 700 Egyptiens, couvrant une période de 3000 ans, a prouvé que la forte usure des dents est principalement le fait de la consistance des aliments et de la silice des plantes et non le résultat des poussières et grains de sable qui souillent alors la nourriture. De plus le microscope a permis de montrer, par la grande régularité des aspects de l'usure des dents, la stabilité des ressources alimentaires et de leur mode de préparation dans l'antique Egypte. Le caractère typique est constitué de cannelures qui résultent du frottement des graminées et des cypéracées, plantes riches en silice.

Le professeur GOYON a bien voulu apporter quelques renseignements concernant la comestibilité des Cypéracées : « il faut noter que, selon l'état actuel des connaissances, ce sont les rhizomes qui étaient consommés. Parmi les *Cyperus* seul *Esculentus* L. était utilisé (KEIMER 1984). Il faut écarter toute consommation de *C. rotondus* (KEIMER) à l'état de « tige » ou « pousse » ; en revanche, les rhizomes de *C. longus* et de *C. rotondus* L., bien que très fortement aromatiques, peuvent éventuellement avoir servi de nourriture ».

L'usure de deux molaires de la momie a été examinée au microscope électronique à balayage. Les micro-dommages sont particulièrement nombreux et bien marqués, ce qui nous attribuons, après quelques essais de micro-dureté, à une mauvaise qualité des tissus. L'examen général confirme cette hypothèse en révèlant de nombreuses hypoplasies (fig. 7). Nous avons groupé les aspects de l'usure des surfaces triturantes comme suit :

1. de nombreuses stries très fines de 0,2 à 2 μm de largeur, groupées en séries de parallèles (fig. 8),
2. de larges stries (fig. 9),
3. des zones d'émail poli et peu strié à faible grossissement,
4. des puits et éclats de dimensions très variables (fig. 10),
5. de fines cannelures espacées d'environ 10 μm (fig. 11 à 14).

Les cannelures de la dentine (fig. 11 et 12) et de l'émail (fig. 13 et 14) sont caractéristiques de l'usure des dents des anciens Egyptiens. Les cannelures résultent du polissage des structures des tissus dentaires par la silice contenue dans les cellules de certains végétaux. On retrouve d'ailleurs ces aspects sur les dents des Esquimaux ayant consommé des lichens, de plus la comparaison avec l'usure des dents d'animaux à diète connue a montré que les graminées et les cypéracées produisent également des cannelures (PUECH 1987, PUECH *et alii* 1986). Nous ne supposons pas que la silice des plantes est seulement le responsable de l'usure des dents puisque de fortes striations et de nombreux éclats voisinent avec les cannelures mais, du fait des faibles dimensions de cette silice des

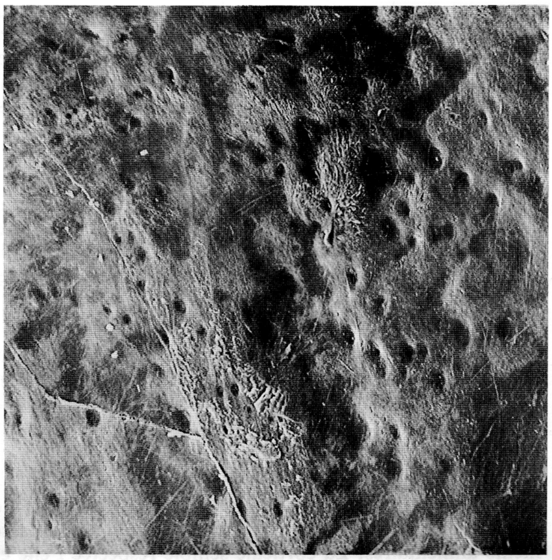


Fig. 7 — L'émail des dents de la momie est hypoplasié. Cet émail offre une moindre résistance à l'usure.
Cliché M.E.B. réalisé par P.F. PUECH. (x 50).

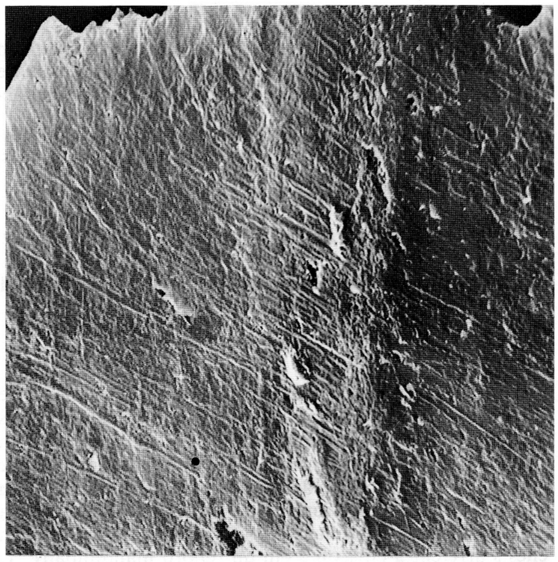


Fig. 8 — L'émail des surfaces triturantes est par endroits usé en « coups de lime ». Ces fines stries résultent des mouvements de latéralité de la mandibule visant à moudre les aliments.
Cliché M.E.B. réalisé par P.F. PUECH. (x 200).

Fig. 9 — Les plans inclinés des surfaces triturantes ont été fortement altérés par l'action en cisaille qui se produit lors de la fermeture en relation centrée. Les forces exercées sont alors maximales.
Cliché M.E.B. réalisé par P.F. PUECH. (x 200).

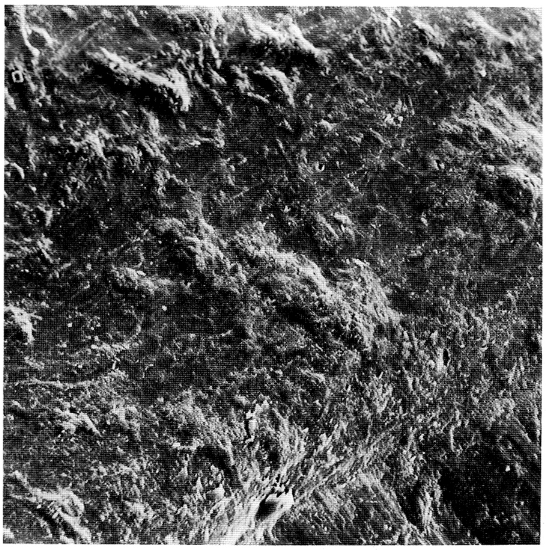


Fig. 10 — L'action en tenaille ou en pilon- et- mortier fatigue l'émail et provoque des éclats. L'émail détaché et les grains abrasifs produisent des indentations dans la surface.
Cliché M.E.B. réalisé par P.F. PUECH. (x 150).

tes et de sa dureté, un polissage de la dentine et de l'émail a accompagné une usure commune aux dents humaines de cette époque. Ainsi s'explique l'usure très particulière des dents de cette momie, et la stricte identité des aspects microscopiques avec ceux des autres Egyptiens que nous avons observés lors d'une précédente étude.

Nous ajouterons ici une remarque : les dents examinées offraient l'avantage de ne pas avoir été contaminées par la poussière ou autre pollution, la cavité buccale étant parfaitement close jusqu'au moment du prélèvement.

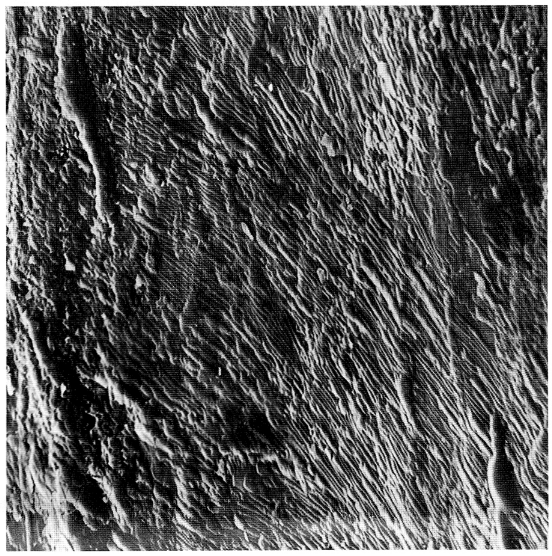


Fig. 11 — L'usure a poli la surface dentinaire et révélé la nature des structures du tissu.
Cliché M.E.B. réalisé par P.F. PUECH. (x 270).

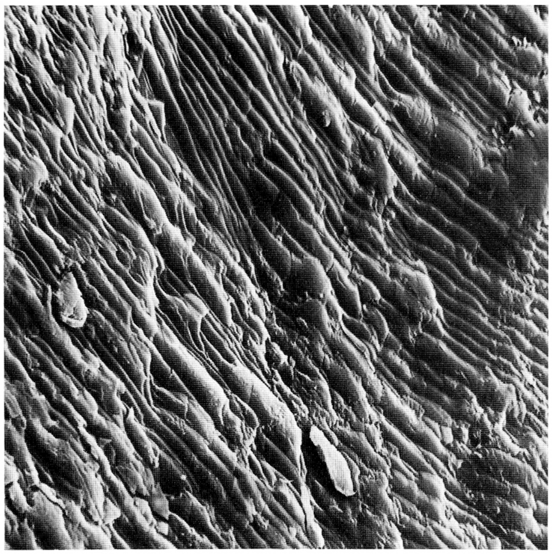


Fig. 12 — A fort grossissement on objective l'usure différentielle sous l'action d'un fin polissage.
Cliché M.E.B. réalisé par P.F. PUECH. (x 1000).

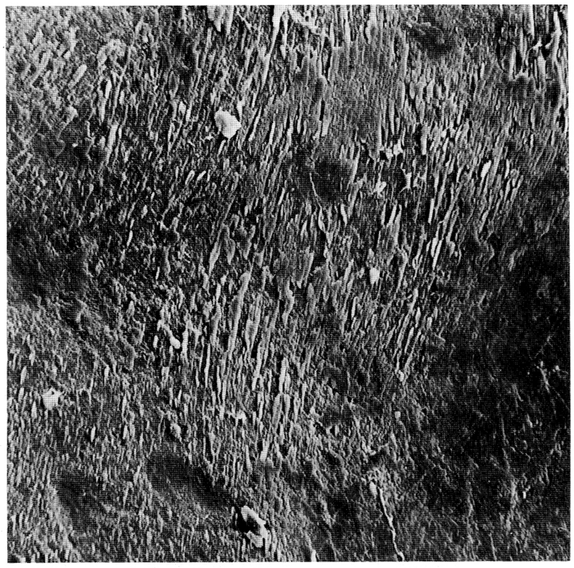


Fig. 13 — Le polissage a également révélé l'arrangement des prismes de l'émail. L'apparente irrégularité du polissage au grossissement 180, est le résultat de micro-fractures de ce tissu dur qui forme l'écorce de la couronne dentaire.
Cliché M.E.B. réalisé par P.F. PUECH. (x 180).

Fig. 14 — A plus fort grossissement l'empilement des prismes et leurs sections sont visibles. Ces cannelures de l'émail comme celles de la dentine sont caractéristiques de l'usure des dents des Egyptiens.
Cliché M.E.B. réalisé par P.F. PUECH. (x 600).

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SCIENCES

Une étude peu banale

Autopsie de la momie

Disposant de techniques ultra-modernes, des chercheurs, issus d'horizons divers, ont cherché à percer quelques secrets des prêtres embaumeurs.

Le visage dégagé de sa gangue de bandelettes revient à la lumière, après deux millénaires et demi dans les ténèbres. (Photographie de MCR)

Durant trois millénaires dans l'Egypte pharaonique, la momification a été la voie de passage de ce monde vers l'au-delà, vers la lumière de Rê, le dieu du Soleil, les Egyptiens ayant la foi en un avenir solaire réservé à tous les croyants. Les momies et le mystère de leur préparation ont de tout temps fasciné les hommes.

Dans un livre remarquablement illustré *Un corps pour l'éternité. Autopsie d'une momie* (1), Jean-Claude Goyon, professeur d'égyptologie, spécialiste des rituels funéraires, de médecine et de pharmacopée de l'Egypte antique, et Patrice Josset, médecin hospitalier spécialisé en anatomo-pathologie et passionné par la médecine ancienne, ont voulu tenter de percer les mystères de la momification : en comparant les textes rituels antiques à l'« autopsie » d'une momie du musée Guimet d'histoire naturelle de Lyon.

Il a fallu quatre jours pleins pour réaliser cette étude peu banale, menée grâce à la rencontre et la collaboration de chercheurs enthousiastes issus d'horizons très divers : égyptologue, médecins et parmi ceux-ci, outre le docteur Josset, un chirurgien orthopédique et un urologue, anthropologue, spécialistes des insectes et des pollens, spécialistes et restauratrices de tissus anciens...

Avant d'être extraite de sa gangue de linges, la momie a d'abord passé un examen au scanner à l'hôpital Edouard-Herriot de Lyon. *« C'est une étape fantastique car elle nous a permis d'obtenir des renseignements extrêmements précis, avant même de toucher à la première bandelette*, remarque le docteur Josset. *Le squelette, entouré de masses musculaires minces, était conservé dans son intégralité, aucune fracture ne brisait son harmonie. Le tronc, vidé de ses organes, contenait plusieurs paquets oblongs, les paquets canopes bien connus des égyptologues (ils contiennent les viscères déséchés).* »

Quant au crâne, plusieurs éléments attiraient l'attention : le cerveau et les yeux avaient disparu ; la partie postérieure était remplie par de la résine solidifiée après avoir été introduite chaude par les prêtres embaumeurs.

Textes rituels

Cet examen au scanner ouvre des perspectives passionnantes pour l'avenir. *« Il nous a permis d'étalonner les différentes densités rencontrées : celles de l'os, celles des tissus, des résines...* explique le docteur Josset, *ce qui va servir ensuite à examiner d'autres momies et à repérer d'éventuels fragments de paille, de poteries ou autres, sans avoir à leur ôter leurs bandelettes, étape extrêmement longue et délicate.* ».

Impressionnant gisant plus de deux fois millénaire, riche encore de son mystère, la momie a été installée dans une salle d'autopsie spécialement recréée pour la circonstance (car tout le déroulement de cette fabuleuse intervention a été filmé et fait l'objet d'un film qui devrait être diffusé prochainement sur FR3). Momie anonyme car rien ne subsistait, ni son sarcophage, ni les éléments funéraires traditionnels, ni même une inscription à l'encre en écriture hiératique, démotique ou grecque, susceptibles de fournir quelques renseignements.

Lors du déroulement des bandelettes, les chirurgiens ont été frappés par l'extraordinaire ressemblance entre les bandes confectionnées à l'époque et celles utilisées encore aujourd'hui : même taille et mêmes lignes colorées.

Aucune trace de champignons ne fut trouvée, tant sur ces tissus que sur le corps de la momie ; cela témoigne de l'extraordinaire talent des prêtres embaumeurs.

Comment arrivaient-ils à un tel résultat ? Les textes rituels le disent en partie, mais certaines plantes citées ne sont pas toujours bien identifiées. Le fait d'autopsier cette momie et de l'étudier en bénéficiant des techniques biochimiques les plus perfectionnées devrait fournir des éléments décisifs. Car les égyptologues savent bien que le corps, après avoir été vidé de ses viscères (foie, intestin, cœur, reins, poumons...) et de son cerveau (en perforant la lame osseuse qui sépare le crâne du sommet des cavités nasales), était exposé au soleil et séché au natron — un mélange de sels naturels — avant d'être embaumé. Mais quel type de résine utilisaient-ils, ces résines qui prenaient la place du cerveau et entouraient les paquets de viscères déséchés, les paquets canopes replacés dans la cavité abdominale ?

Coléoptèress

« Grâce au chromatographe et au spectromètre de masse, des chimistes sont en train de les étudier. Mais ces examens sont très complexes, souligne le docteur Josset. *Un produit a pu être identifié. C'est le ladanum, une gomme résine qui provient du ciste, plante qui pousse en Palestine et en Crête. Cette découverte témoigne des circuits commerciaux existant à l'époque. A ce propos, dans la Bible, il est fait mention d'une caravane qui transportait un produit précieux le ladanum, caravane qu'avait suivie Joseph lorsqu'il fut vendu par ses frères aux Egyptiens.* »

Les fragments tissulaires provenant des différents paquets canopes intéressent aussi les chercheurs au plus haut point. Comment étaient-ils déshydratés ? Certains l'étaient par le natron, mais d'autres pas. Car il est prodigieux de pouvoir encore, plus de deux mille ans plus tard, examiner au microscope des fragments d'organes comme le cœur ou le poumon. C'est ainsi que des lésions pulmonaires importantes, qui pourraient correspondre à une turberculose ou une pneumonie, ont été détectée. Lésions susceptibles d'être à l'origine du décès de l'inconnu momifié.

Au microscope électronique à balayage, une image saisissante, celle d'une patte griffue d'anthrène, immobilisée pour l'éternité. Ces coléoptères, friands de viande séchée, ont déposé leurs larves entre le moment où le corps a été desséché et celui où l'on a versé la résine et mis les bandelettes. Mais les remarquables soins des prêtres égyptiens les ont empêchés de faire des ravages.

Ces prêtres, ces médecins, ces embaumeurs de l'époque pharaonique avaient une science consommée de la chirurgie et de la chimie. Les recherches menées aujourd'hui pour tenter de percer leurs secrets devraient en faire bénéficier la pharmacopée actuelle. Car leurs connaissances des plantes et des essences avaient atteint un degré probablement inconnu aujourd'hui.

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(1) *Aux Editions du Léopard d'or, 8, rue du Couedic, 75014 Paris.*